than for the comparatively undisturbed fields.

Upon return to Washington, the investigation was amplified so as to embrace another magnet of different style, make and magnetic moment, and the weighings made for eight equidistant orientations of magnet (north end towards magnetic north, northeast, east, etc.). Besides this, the balance itself was swung in order that the beam would not always be directed in the same way for the same orientation of magnet so as to exclude in every way possible any effect that might be attributed to magnetic impurities remaining in the balance, which the special tests failed to disclose. It was found that the orientation of *balance* had no appreciable effect upon the results obtained.

However, a systematic curve of differences or residuals from the mean weight, for the eight orientations of *magnet,* resulted—somewhat similar to the deviation curves which represent the effect on the compass of the iron on board a vessel. Two waves of about the same amplitude were clearly discernible—a semicircular one and a quadrantal one—the latter apparently associated with the inductive effect of the earth on the magnet in its various positions. On account of the presence of the quadrantal term, reversal of magnet does not eliminate the effect on the weight due to the outstanding residual magnetic force. Hence the mean result of weighings of a magnet in two positions 180° apart will not necessarily give the true weight, or say the weight which the same substance would have if demagnetized. This was proved also by repeated magnetizations and demagnetizations of two different magnets. To get the true weight of a magnet within the accuracy attainable with the balance used, the weighings of the substance when magnetized would have to be made for *at least* eight equidistant positions.

The observations were repeated on three days, October 10, 11 and 12 at the Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Md., and practically the same results obtained as before.

For the two stations, Washington and Cheltenham, the range in the results for the various orientations of magnet was about 0.05 mg. (1/660,000 part of weight of magnet).

The investigation is being continued.

R. L. Faris,
Secretary

DISCUSSION AND CORRESPONDENCE

VARIATION OF ENVIRONMENT

The present writer has always been an advocate of the theory that variation of organic beings is influenced by the environment, and he does not believe in the existence of so-called spontaneous or congenital variation.

Since it is a well-established fact that no two individuals of the same species are absolutely identical, variation seems to be general, and it has recently been alleged that variation, the natural diversity, organisms, is a fundamental law, and is to be observed even when the environment remains unchanged.[1] But, in my opinion, this is not correct, and I believe that *no two individuals of any organic form grow up under identical conditions.*[2]

The idea that the latter may happen, that two individuals develop under the same environment, demonstrates that those who hold it look upon environment in a very superficial way, and do not appreciate the great variety of conditions involved, and thus it does not seem to be amiss to call here attention to the variety of features which constitute environment, and we shall see, if we understand this properly, interesting correlations to certain

[1] See Cook, in Science, September 7, 1906, p. 306, "Individual diversity persists in spite of uniformity of conditions."

[2] In Science, July 12, 1907, p. 50, Cook quotes my sentence (Science, December 7, 1906, p. 729): "*if the environment remains uniform, perfect uniformity of individuals will result,*" but misunderstands it entirely, believing that I hold the opinion that uniformity of individuals may or does actually exist. He would not have made this mistake, if he had paid due attention to the sentence immediately following this one: "but since it is practically impossible," etc. Cook's definition of *Amphimixis* in the same article is highly surprising to me, and I should like to know where it is to be found in Weismann's writings, for I have never come across it.

types of organic variation will be revealed, which are highly suggestive.

That each organic form depends on a special environment, and is able to exist only under a certain set of conditions, is generally known,[3] but a specific environment is by no means a firmly fixed, unalterable and unchangeable factor, even if we are justified in saying that in a particular case the environment has remained or remains the same. There are, indeed, certain major features in each set of environmental conditions, which remain unaltered, but there are always others which may and do vary.

To make this more clear, let us take a single factor as an example, for instance, climate. Each organic form depends on a certain climate, but climate is not a fixed, permanent and uniform factor, even within the tropics. What we call climate is an average condition resulting from positive and negative deviations of a number of factors (temperature, precipitation, etc.) from a normal value. Now we all know that these deviations from the average again are not the same in different periods: we talk of daily, monthly, seasonal changes, and even the average conditions of different years are not identical, so that we observe periods of climatic variations extending over a number of years.

The same is true of any other environmental condition, and if we keep in mind the great complexity of factors which enter into the concept of "environment," which will be best understood by those who have paid attention to the modern studies in ecology, we shall be able to correctly estimate the value of this idea, that the environment, the ecological conditions, under which a given species lives, is not a fixed set of unchangeable features. There is hardly a factor which is constant, but it generally goes at certain times beyond a certain average or optimum in one or another direction.

These deviations from the normal state we may call by the name of "fluctuations," a term which is familiar. The chief feature of fluctuation is that, when there has been, for a certain time, a deviation from the normal in one direction, it is compensated, more or less, at another time, by a deviation in another direction. Sticking to our example of the climate: the darkness and coolness of the night are compensated by the light and the heat of the day; the sun shines in the morning from the east, this is compensated by the position of the sun in the evening; cool and damp days alternate with hot and dry days; the seasonal cycle of the year is characterized by opposite conditions prevailing at different seasons. Further, there may be a series of years of unusual dryness, of excessive heat, which is counterbalanced by a series of years of the opposite character, and so forth.

Yet we know that variations of environment are not always of this character, fluctuating around an average, which remains more or less constant. We have ample evidence of variation, which tends to change the average condition in a certain direction, and to change it permanently. We know that the climate of a country changes, that it becomes, in the course of time, a different one from what it used to be. I hardly need to mention examples, since everybody knows what I am referring to: yet the change of environment brought about by the advent of the Glacial period may be quoted, and also the change caused in the environmental features of this continent by the immigration of the white man.

To one thing, however, I want to call special attention. There is no sharp line to be drawn between variation fluctuating around a certain average, and a permanent change of the latter. As we have seen, the average may change for a short time in one direction, and may go back subsequently in the other direction; but gradually the change of the average in one direction may begin to prevail, it may not entirely be compensated by the opposite movement, and finally the latter may be suppressed altogether, so that only the movement in one direction remains, which then may end in the establishment of a new set of environmental conditions. This change we may call by the name of "mutation," and the use of this term in this sense will be justified later on.

[3] See Brooks, in *Proc. Amer. Philos. Soc.*, 45, 1906, p. 75.

Under the assumption that organisms respond to or react upon variations of the environment, we see that a difference in the character of the reaction of the organism should be observed.

If an organic form responds to fluctuating variations of the environment, this response should also be of a fluctuating character. Considering the vast variety of environmental conditions, such responses to fluctuating variation should be very frequent, indeed, should be the rule, and this serves to explain the fact of the "natural diversity of individuals," which, according to this theory, is to be regarded as the consequence of the different reactions of individuals to fluctuating variation of environment, while they grow up. These reactions, however, can not be permanent, either with the individual, or with the species, for the individual, as well as the species, may come and will come, subsequently, under the opposite influence, and thus the first reaction will be paralyzed by another one. This kind of organic variation is well known, recently it has been called (by de Vries) "fluctuating variation," and it is the typical "variation," as understood by Darwin. This variation is not very apt to be transmitted by inheritance, chiefly by reason of the fact that its cause is not a permanent one: even if there should be a tendency toward hereditary transmission, this tendency is counterbalanced by the "fluctuating" character of its cause.

If, however, the environment begins to change in a definite direction, it necessarily must produce in the organisms a tendency to react again and again in the same way upon the changed environment. Thus we obtain a condition which has been called by C. H. Merriam "pressure of environment." If organisms react at all upon external influences, the change of the environment in a certain direction must act as a pressure upon them, compelling them also to show a definite direction in their variation. Thus we are to expect "definite variation," which indeed is known among organic beings under different names, for instance, "orthogenesis" (Eimer) or "mutation" (v. Waagen),[4] and if there is any possibility that the reaction upon an external stimulus may become transmissible to the offspring, this should happen under such conditions, the tendency to transmit acquired characters being not counterbalanced any more by the opposite direction in the variation of the environment, but, on the contrary, being favored and emphasized. In this way, I believe, "mutation" of species (their transformation) is rendered possible, namely, by the pressure of permanently changed environmental conditions, or by "mutation of environment."

It is interesting to note that the above considerations lead us to assume the existence of two kinds of organic variation. First, a "fluctuating variation," which is not transmitted. I deliberately do not say transmissible, for it may be transmissible; all we can safely say is, it is not transmitted. The second kind of organic variation is transmitted: it has the quality, or the tendency, to "breed true," thus changing an existing species in its totality into another one. This process is identical with v. Waagen's "mutation." However, there can not be a sharp distinguishing line between *fluctuation* and *mutation,* and these two forms of variation should run into each other, any fluctuation being capable of being transformed into a true breeding mutation, as soon as its cause becomes permanent: that is to say, as soon as the environmental conditions, to which it is a reaction, are made permanent, so that they can bring to bear their influence upon each generation.

A. E. Ortmann

Carnegie Museum,
Pittsburg, Pa.

[4] Here we see why I selected above the term "mutation" for definite changes of environment, namely, to mark the correlation to organic "mutation." This is by no means the "mutation" of de Vries, a term which should be abandoned, being preoccupied on the one hand, and ill defined, in fact ill conceived, on the other. See my articles in Science, May 11, 1906, p. 746; June 22, 1906, p. 947; August 17, 1906, p. 214; February 1, 1907, p. 185.